PATENT SPECIFICATION (11) 1384 121

1384 121

(21) Application No. 9098/72 (22) Filed 28 Feb. 1972

(44) Complete Specification published 19 Feb. 1975

(51) INT CL² D02G 1/00//3/02

(52) Index at acceptance

D1W 3

D1F 40X 40Y 42 43A 45C 52 53

(72) Inventors ROBERT MILLER
ROBERT JOHNSON CLARKSON and
FRANK CHARLES CESARE

(54) POLYPROPYLENE YARN

(71) We, UNIROYAL, INC., a corporation organised and existing under the laws of the State of New Jersey, one of the United States of America, located at 1230 Avenue of the Americas, New York, 10020, United States of America, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to resilient textured polypropylene yarns which are particularly useful in carpeting and upholstery.

Except for its poor resiliency, polypropylene is an ideal fibre to be used in carpeting and upholstering. Resiliency is a measure of the ability of a fibre to recover fully its original dimensions upon release of a stress which is compressing it. In the case of polypropylene carpet the poor resiliency is demonstrated by the "walking out" of a sculptured carpet in highly trafficked areas or by the matting which occurs on the walked on areas of level pile carpets. The matting phenomenon also occurs in upholstery which contains polypropylene pile yarn.

The present invention provides a resilient textured yarn comprising crystalline polypropylene filament, the yarn having been formed, textured and heat treated in such a way as to have specific characteristics. According to the invention, in such a yarn the filaments have a random, three dimensional crimp with at least 75% of the crimp having non-helical, rounded convolutions and with six to twenty crimps per inch; more than 80% of the filaments possess substantially no plastic deformation along their lengths; and the yarn has a tenacity of less than 2.5 grams/denier, a crimp permanence as herein evaluated of 20—70 and a modulus retention as herein defined of at least 30% above average at 8% elongation. The total of these characteristics results in a marked improvement in the resiliency and performance of the polyproplene yarns which possesses properties comparable to textured nylon yarns. The yarns of the present invention show an improved resiliency (as compared to a standard polypropylene yarn) while maintaining the additional properties necessary to result in a commercially acceptable high quality carpet or upholstery.

It is believed that the yarns of the present invention have a unique molecular and crystalline internal structural configuration which result in the given physical characteristics. These characteristics will now be discussed in more detail.

1. The filaments which comprise the yarn have a three dimensional crimp. Crimp is a term used to describe the waviness of a fiber and is a measure of the difference between the length of the unstraightened and that of the straightened fibers. Crimp can be produced in most fibers using texturing processes. The crimps induced in the filaments of the yarn of the present invention have an arcuated configuration in three axes (such as in an "S") as opposed to filaments possessing a sharp angular configuration (such as in a "Z") which are not included within the scope of the present invention. The effect of the three dimensional crimp is that the filaments in the yarns do not lean in one direction on compression of the pile.

2. The crimp in the filaments comprising the yarn is random in nature so that the filaments will not nest together and lean in unison when the pile is compressed.

3. The filaments have an average crimp count range of 6 to 20 crimps per inch, preferably 9 to 15 crimps per inch.

4. At least 75% of the crimp in the filaments has the rounded arcuate convolutions described above; however, the filaments comprising said yarn are non-helical along their length. The sharp edge (Z) angular configuration in the crimp as produced by a stuffer box assembly is unsatisfactory since this form leads to weak spots on repeated compression. Helically crimped filaments are unacceptable because the yarn tends to nest and become entangled on compression, there-

[Price 33p]

The following table lists the % Crimp Permanence for various commercial yarns as determined using the above noted procedure.

TABLE 1

	% Crimp Permanence
*Herculon (Hercules Inc.)	9.0
*Polycrest (SDR-25 Uniroyal Inc.)	12.7
*Polycrest (SDR-1 Uniroyal Inc.)	13.0
Textured Polypropylene yarn of present invention	30—50
*Chemstrand Nylon 2600 den.	32.0
Allied Nylon 2600 den.	29.1
duPont 501 Nylon	50.4

*"Chemstrand", "Polycrest" and "Herculon" are Registered Trade Marks.

8. The yarn exhibits some elastomeric character at low elongations. This is demonstrated by drawing the yarn on an Instron (Registered Trade Mark) tester to 10% elongation. Comparison of the tenacity at 8% elongation on the first outgoing cycle and return cycle indicate at least a 30% above average modulus retention, i.e. the textured yarn returns or retracts at least 30% more than identical untextured yarn. (In this case the textured yarn sample is initially tensioned sufficiently to just remove the texture). The elastomeric property noted aids the resiliency of the yarn because the hysteresis for energy lost on compression or bending of the filaments is reduced.

(Bending of a filament results in elongation on one side and compression on the other).

The polypropylene which is used in the present invention may be any of the commercially available essentially linear highly crystalline isotactic polypropylenes which have a high molecular weight and a melting point of about 165°C. The polypropylene used in the present invention is generally prepared using a coordination polymerization method. This polymerization method uses a reduced transition metal catalyst, generally in the form of a slurry of a very small solid particle in an inert medium. This method is well known in the art.

Various additives including such dye receptors as polyamines, polyvinylpyridines, polyamides, organic pigments such as phthalocyanine, inorganic pigments such as the cadmium salt series, carbon black, and stabilizers, plasticizers, flame retardants may be incorporated into the polypropylene to modify the properties thereof.

The conversion of the bulk polypropylene to fiber form is accomplished by any of the usual spinning methods. Since polypropylene can be melted under reasonable temperature conditions, the production of the fiber is preferably done by melt spinning as opposed to solution processes.

In the process of melt spinning, the polymer is heated in an extruder to the melting point and the molten polymer is pumped at a constant rate under high pressure through a spinnerette containing a number of holes. The liquid polymer streams emerge downward from the face of the spinnerette usually into a cooling stream of gas, generally air. The streams of molten polymer are solidified as a result of cooling to form filaments and are brought together and are wound up on bobbins. If desirable the polymer melt in the extruder may be protected from oxygen by blanketing it with steam or an inert gas such as carbon dioxide or nitrogen.

After the filament has been prepared a drawing step is usually performed to orient the molecular structure of the filament. The drawing step may be carried out in any convenient manner using techniques well known in the art such as the use of a heated pin, a heated plate, heated liquids or cool liquids. The methods are not critical but the draw ratio (i.e. drawn length/undrawn length) should be kept below 2.5:1. The filaments are combined to form yarns which are then textured to impart a crimp therein. Any texturing means which imparts a three-dimensional non helical, curvilinear rounded configuration to the yarn can be used to prepare the yarns of the present invention. Generally, a stream of compressible fluid such as air, steam, or any other compressible fluid or vapor capable of exercising a plasticizing action on the yarn is vigorously jetted from a nozzle through a portion of the yarn as it continuously travels through the texturing device, at a temperature above 200°F.

The temperature of the fluid must be such that the yarn does not melt. If the temperature of the fluid is above the melting point of the yarn it is necessary to shorten the time in which the yarn dwells in the texturing region.

There are a number of methods and devices for producing a turbulent stream of fluid for the purpose of texturing yarns. Suitable methods and devices are described in U.K. Patent No. 1,044,697 and copending U.K. application No. 5924/74 (Serial No. 1,377,427) although the invention is not limited to these methods or devices.

After a crimp is imposed in the yarn as described above the yarn is taken from the texturing region with a minimum of tension in the highly compacted state and is post-heated in suitable means at temperatures from about 250°F to just below the softening point of the filament for a sufficient period of time to allow the crimp imparted during the texturing step to be permanently set into the yarn. For some applications de-

TABLE 2

Carpet	Initial Pile Ht. (Inches)	Wt.Oz./ Sq.Yd.	Cycles of Pounding Rating in % Matting* 1000	3000	10,000	20,000
Polycrest (SDR-25-4000 den.)	.245"	30	9.0	12.6	18.4	19.6
501 Nylon (4000 den.)	.253"	30	5.1	6.7	8.3	10.7
High Resiliency Polyprop. 4000 denier	.231"	30.8	5.2	6.5	9.9	12.1

$$\% \text{ Matting} = \frac{hi-h}{hi} \times 100$$

h=pile height (less backing) after matting test (inches)
hi=initial pile height (less backing)

Table 2 shows that the yarns of the present invention compare favourably with nylon.

Example 4

Equal weight carpets (approximately 25 oz. per sq. yd.) of 156 filament (4000 denier) polypropylene yarn containing 3% poly-(vinylpyridine) were tufted into a sculptured pattern. These samples were all dyed to the same color, latexed, and put into highly trafficked areas. The number of people walking through this area were counted by a photocounter. These carpets were graded subjectively at intervals during the test for matting and pattern deformation.

TABLE 3

Sample	Crimp Permanence	Tenacity (g/den.) of Textured Yarn	Draw Ratio	Matting & Pattern Deformation Rating* at Number of People shown 8,000	16,000	24,000
A	13.0	3.1	4.0:1	S—D	D—E	E
B	14.0	2.5	3.0:1	S	S—D	D
C	12.7	1.9	2.5:1	S	S	S—D
D	13.5	1.4	2.0:1	N	N—S	S
E(Stuffer Box)	9.0	2.0	2.5:1	S—D	D—E	E
F	38.0	1.8	2.5:1	N	N	N—S

*N=None — S=Slight — D=Definite —E=Extreme

Samples A, B, C and D show the change in resiliency as a function of tenacity alone. The samples were textured using the method described in Example 1, but were not heat treated after texturing to permanently set the crimp. These samples have the crimp characteristics required in the present invention (three dimensional shape, etc.), except for Crimp Permanence and elasticity. Sample E lacks the crimp characteristics as well. Although the tenacity of Sample E is low (equivalent to Sample C), the resiliency of Sample E is lower due to it having been crimped in a stuffer box so it possesses a two dimensional crimp containing sharp edges and plastic deformation. Sample F was prepared as described in Example 1 including a heat treatment to permanently set the crimp, and a 4000 denier yarn was obtained. This yarn has all the requirements of the present invention and demonstrates the improved resiliency that can be expected. This example shows that no single property or characteristic of polypropylene yarns is responsible for the unexpectedly high resiliency yarns of the present invention. The yarns of the present invention result from the total combination of essential properties and characteristics as set forth herein.

WHAT WE CLAIM IS:—

1. A yarn comprising crystalline polypropylene filaments, in which the filaments have a random, three-dimensional crimp with at least 75% of the crimp having non-helical, rounded convolutions and with six to twenty crimps per inch; more than 80% of the filaments possess substantially no plastic deformation along their lengths; and the yarn has a tenacity of less than 2.5 grams/denier, a crimp permanence as herein evaluated of 20—70 and a modulus retention as herein defined of at least 30% above average at 8% elongation.

2. A yarn as claimed in Claim 1 wherein